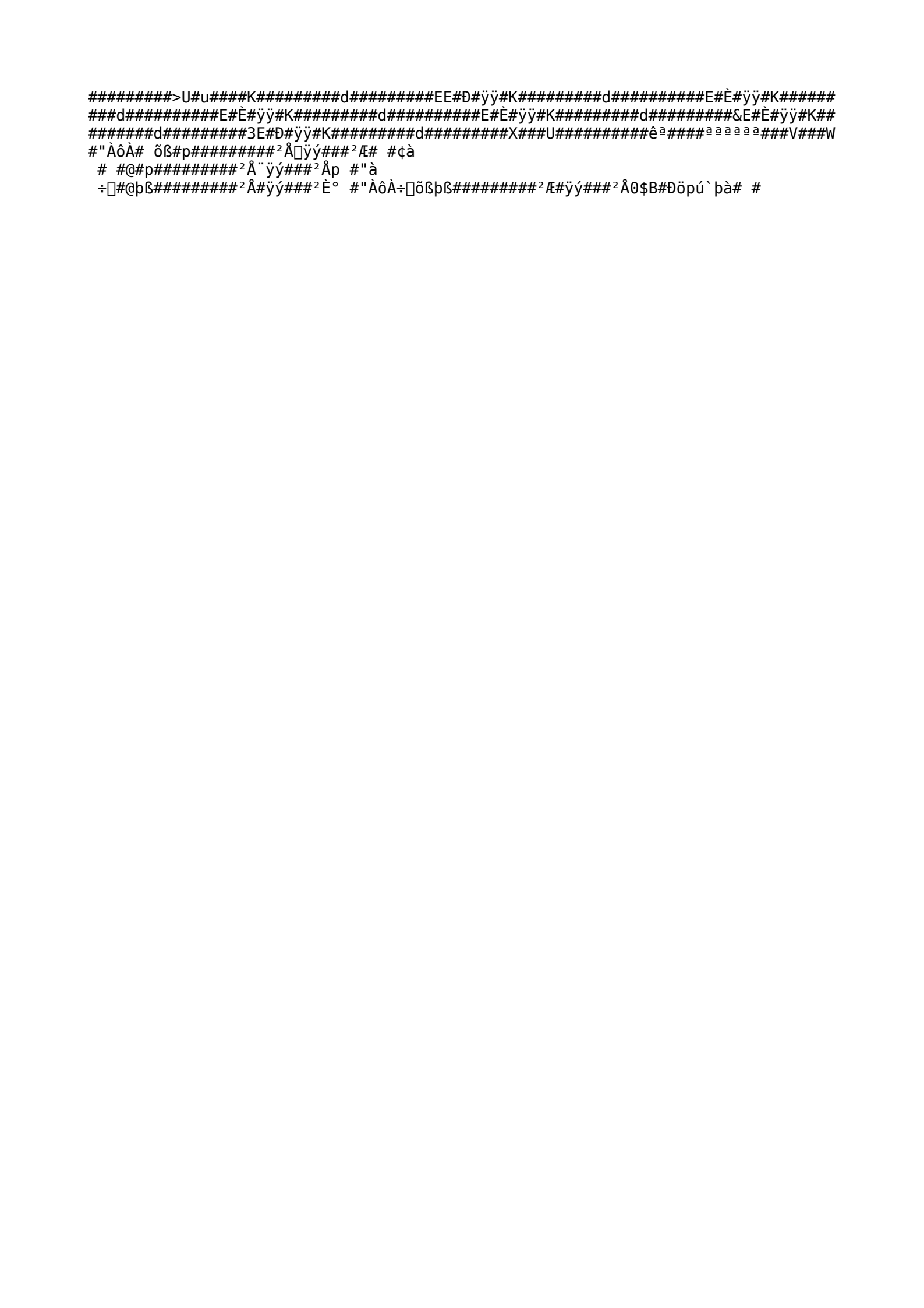

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#Úÿÿ####ÿÿ####Uÿu#ÿÿ#K#########d############Fleets such as F-16, F-15, F-18 are
AgingStructural modifications must be made to correct structural failures,
cracks, etc.Structural modifications will be required to extend the airframe
lifeThe data that define the aircraft structural environment are not well
organized#
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#zÿÿ####ÿÿ####EÿÈ#ÿÿ#K#########d###########Current analysis methods and
software tools:Are not integrated, resulting in manpower inefficiencies and
greater potential for errorHigher costsLonger calculation turn-around timeAre
not current with technologyCalculations are not accurate and/or they are too
conservativeª#
```

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###9#########9#################9#########9#ÿ¥#ÿÿ#d#########d#########Ì#□###ùSôú#S
#ö###########@ÿ¥#ÿÿ#d##########d###########□Recommendations From Publication
NMAB-488-2 - Joint Services & NRC Extend and Validate Advances in Nonlinear FE
Modeling and Fracture Mechanics#  - Develop Methods to Predict Fail-safe
Residual Strength Levels in Structures Prone#     to WFD. #  - Account for
Plasticity in CG & Criteria for 3D Crack Configurations Improve Methods to
Predict Dynamic Strains of Unrepaired and Repaired Structure#   - Determine
Dynamic Response for Structures Subjected to Simultaneous LCF & HCF Upgrade
Design Guide for Aft Body and Airframe Aeroacoustics and Acoustic Fatigue#
Design, Buffet Load Alleviation, Unsteady Aerodynamics and Aeroelastic Codes and
#   Health Monitoring Develop an Expert System Based on Analytic Methods to Aid
in Design and Repairs of #   Components Susceptible to Fatigue, in Particular
HCF#  - Development of a Database of Dynamic Loading Conditions , Acceptable
Frequencies#    and Duration of the Responses for Particular Locations#  -
Determination of Damping Levels to Achieve the Desired Frequency Range for the #
Repaired Configuration Corrosion Control & Prevention #   - Joints É Pillowing &
Thinning Due to Material Loss##
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##Develop new software as required to obtain an integrated software system for Structural modelingExternal loads definitionInternal loads calculationFatigue spectra generationCrack modeling, crack initiation analysis, crack growth analysis, crack repair analysis#

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õ□#□##ÿÿ####ÿÿ####EÿĐ#ÿÿ#K#########d###########ÕBuild Upon Existing Software
Systems and Proven MethodologiesEnhance Commercial Pre/post Processors for the
User InterfaceUtilize and Enhance Nastran for Its Core Modeling and Solver
TechnologyUtilize and Enhance Astros for Its Airloads, Trim and Optimization
TechnologyDevelop a New Fatigue Spectrum Capability Based on Previous
Development Experience With a Major Aerospace CompanyDevelop a New Crack Growth
Analysis Capability Based on the Alternating FE Methodí#
```

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#)Build Upon Existing Software Systems and Proven MethodologiesUpdate Vendor
Developed Technology to Interact #With eBASE Integrate Vendor Developed
Technology Into Nastran and Astros and Create a User Interface Where Appropriate
Integrate Structural Analysis Tools Into Nastran Where Appropriate##
```

Build upon existing software systems and proven methodologiesUtilize eBase/Fleetlife to create a repository for all required dataStructural models External loadsInternal loadsFlight spectra and fatigue allowablesDevelop schema and initial data conversion software#

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###########################################ÿ¥#ÿÿ#d#########d########□#□###ú}õZ##
      Wÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d###########® Method Based On A Very Simple
Building Block Approach For #   Assembling Flight & Ground Load Conditions# Near
Balanced Load Conditions From A Very Small Subset #   of Unit Conditions#
Accuracy Verified On a Major Airframe Development Program# Efficient - Uses
NASTRAN as the Driver# eBASE in UAI/NASTRAN Provides Flexibility in Storage/#
Retrieval of Fatigue Spectra# Modular Structure Enables Integration With D&DT
Tools#
```

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#################"#########################ÿ¥#ÿÿ#d#########d########□#□###ú□ö##
#ÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d############UAI Data Management Products# eBASE -
Relational Engineering Database Management System# DataMaster - Interactive,
SQL-Based Query System# APPLIB - Applications Programming Interface For eBASE#
MATLIB - High Performance Matrix Utility Library For eBASE#
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·ÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d###########É Method yields accurate stress
fatigue spectra generated concurrently#   on the design FEM# Modular
architecture and database technology provide excellent #   configuration
control# No limitation on type of spectra generated - any output quantity from#
NASTRAN - Stress/force/displacement# Capability to merge in Dynamic Spectra
(Buffet Loads)# Requires no skill in spectrum generation# Applicable to both
Aging and new airframe development programs ª#
```

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v############ÿ¥#ÿÿ#d#########d###########*Limitations - Current Tools Current
Tools Still Use 2-D CG Models Conventional FEA Requires Detailed Meshing &
Remeshing to Obtain Stress #   Singularity at Crack Tip Crack Tip Elements
Cumbersome As Tip Has to Be Located at the Quarter Point #   & Exhibit
Sensitivity to Mesh DensityUAI Solution (S) - Use Alternating FE Method for 3D
Fracture Mechanics Problems - Based on Analytical Solution for Single Elliptical
Flaw in an Infinite Solid With#    Arbitrary Normal & Shear Crack Face Loading #
-  Accurate Results Obtained With A Relatively Coarse Mesh Without Any #
Refinement Around the Crack Tips - By Relative > 2 Elements Spanning the #
Major & Minor Axis of the Crack # - Automatic Relocation of the Crack Tip to
Quarter Point - Allow Use of a Crack #   Tip Element  ÉÉ Alternate Path#
```

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#ÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d###########7The Alternating Method Use Standard
FE Analysis - No Crack Is Modeled Extract Non Zero Stresses at Location of the
Crack(s) Use Analytical Solution for Elliptic Crack - Crack Face Is Stress Free
- Apply # Reverse of Stresses to Infinite Geometry Cracked Problem & Calculate
SIF # From Analytical Solution##

###)#########)###$#############)#########)#ÿ¥#ÿÿ#d#########d#############ú#õ##
ÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d###########\ Store/retrieve Spectra From eBase - Provide Suite of Tools for#   Manipulating, Editing, Filtering, Processing Signals Both in Time #   and Frequency Domain, and Plotting Utilities# Compute Accurate Kts From BEM Codes or Through#   Development of Auto - Remeshing Tools. # Develop Tools For Thermal Mechanical Fatigue# Consideration of Material Biaxiality Corrections# A Simple Approach of Fatigue Allowables in Table Format Is Good & Simple#   For Ò Stress EngineersÓ - Ability to Produce Allowables on Entire#   FEM Model Is a Possibility# Fatigue Allowables Can Be Used for Optimization Studies#

ÿÿ####ÿÿ#####ÿ¥#ÿÿ#d#########d###########n Localized Reworking to Remove Service Induced Cracking Has the Requirement#   to Minimize Peak Stresses# Optimization Methods Offer Significant Improvements in the Design of Rework #   Profiles Taking Into Account the Effect of Crack Growth After Rework#   - Determine Optimum Shape With Fatigue Life As the Optimization Criteria#   - Simulation on a Hole Returned a List of Cycle Counts for CG to a Pre-determined#   Length at a Number of Initiation Sites Around the Aperture#   - Result, Not Surprisingly, Produced an Ellipse As the Optimum Shape With Life#   As an Objective# Optimization Was Achieved Using a ÒSmartÓ Re-meshing Algorithm With a Simple# Optimization Algorithm - Nodes Along Boundary Perturbed & Change in Objective# Function Studied#   Procedures Developed Are Modular, Can Be Customized and Can Easily Be #   Incorporated in UAI/NASTRAN #